APPENDIX II

NEW BEDFORD HARBOR PILOT STUDY

PRE-OPERATIONAL MONITORING - PROGRESS REPORT:

Current Meter Studies at the Coggeshall St. Bridge During September 1987

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Introduction

To evaluate the relative effectiveness of various dredging and disposal alternatives in the New Bedford Harbor Pilot Project, physical and chemical measurements in waters beneath the Coggeshall St. Bridge are to be monitored. From these data, an estimation of the downstream transport of contaminated materials will be made. This report summarizes measurements of current velocity, temperature and salinity collected during the second pre-operational phase of the project.

Materials and Methods

In sampling activities of the second pre-operational phase, physical measurements were made on 24 Sept. and 28 Sept. 1987. An InterOceans S-4 current meter was used for the determination of current speed direction, temperature and conductivity. The instrument was held at depth for 4 min, during which time data was collected 2/sec. A 2 minute sampling interval within the 4 minute window was selected and the data averaged for reporting of results. Thus, each datum represents the mean of 120 independent measurements. Salinity was calculated from temperature, conductivity and depth data using a standard conversion formula (Perkin and Lewis, 1980).

Current speed information was used to determine the volume of sample collected at a given sample location to be composited for chemical analyses. This procedure is called "flow proportional" sampling and was used only at this station. Samples were collected at hourly intervals during one flood and one ebb tide cycle. Samples were not collected during slack tide periods. Thus, five hourly sampling periods occured for each state of the tide. For hourly samples collected after slack high tide, these were designated H+1, H+2, ..., H+5. For hourly samples collected after slack low tide, these were designated L+1, L+2, .., L+5.

Sampling occured at two cross-stream locations, denoted "East" and "West". These locations were approximately one-third and two-thirds of the distance from the east to west banks of the channel under the south side of the bridge. At each location, 3 depths were sampled. A "surface" sample was collected 0.5 meters below the water surface. A "bottom" sample was collected 1.0 meters above the bottom of the channel. A "mid-depth" sample was collected at a depth equal to one-half of the total water depth. Total water depth varied with the tide, and differed by about 1.2 meters from high to low tide. This depth was determined from the difference between bridge to channel bottom (fixed) and bridge to water surface (tide dependent).

The formula used for sample volume (V_s) determination is as follows;

$$1.)\ V_s = F_s/F_t \times 6000$$

where F_s and F_t are the flow rates (cm sec^{-1}) at the sample location and the sum total of flow rates at all sampling locations, respectively. The desired volume of the composited sample was 6000 ml.

Samples were composited on these dates using current speed data collected on those dates at the appropriate times. Samples were not composited during intervening days (25-27 Sept. 1987). Instead, equal sample volumes were collected at each location (i.e. 1000 ml) for compositing.

Results and Discussion

Sampling locations at Coggeshall St. bridge are depicted in Figure 1. Differences in tidal height result in a range of sampling locations relative to the bottom for surface and mid-depth samples. The bottom contour reveals a shallower sampling depth on the west side of the channel. The proximity of the bottom sampling locations to the steeply ascending sides of the channel is also apparent.

The pattern of water depth in the channel over time on the two sampling dates is depicted in Figure 2. The two curves are offset by approximately two hours due to the progression of the tidal cycle over time. The amplitude of the tide on the first sampling day (24 Sept.) was about 1.2 meters. Tidal amplitude on the second sampling day appeared somewhat less (1.0 meters).

Profiles of current speed vs. depth for each of the 5 sampling periods on the flood and ebb tides of 24 Sept. are depicted in Figures 3 and 4, respectively. In general, current speed was uniform over depth. Significant differences were observed between east and west sampling locations. For example, currents during the L+1 sampling period were flowing in opposite directions for the two sampling locations. Current speeds between the two locations were different by as much as a factor of two on several occasions.

Profiles of temperature vs. depth for each of the 5 sampling periods on the flood and ebb tides of 24 Sept. are depicted in Figures 5 and 6, respectively. In general, temperature was uniform over depth and varied between 18.5 and 19.5 ^{o}C. Only small differences in temperature were observed between east and west locations. Those differences that are apparent may be real, given the large number of determinations for each data point.

Profiles of salinity vs. depth for each of the 5 sampling periods on the flood and ebb tides of 24 Sept. are depicted in Figures 7 and 8, respectively. The salinity record was incomplete due to an apparent malfunctioning of the conductivity sensor. Only those data falling within a reasonable range (29-33 ppt.) are included. The data was highly variable over time and did not conform to patterns observed for currents and temperature data.

Profiles of current speed vs. depth for each of the 5 sampling periods on the flood and ebb tides of 28 Sept. are depicted in Figures 9 and 10, respectively. In general, current speed was uniform over depth. Significant differences were again observed between east and west sampling locations. For example, currents during the H+1 sampling period were flowing in opposite directions for the two sampling locations. Again, current speeds between the two locations were different by as much as a factor of two on several occasions.

Profiles of temperature vs. depth for each of the 5 sampling periods on the flood and ebb tides of 28 Sept. are depicted in Figures 11 and 12, respectively. In general, temperature was uniform over depth and varied between 17.0 and 18.5 ^{o}C. As on the previous sampling date, only small differences in temperature were observed between east and west locations. Again, those differences which are apparent may be real, given the large number of determinations for each data point.

Profiles of salinity vs. depth for each of the 5 sampling periods on the flood and ebb tides of 28 Sept. are depicted in Figures 13 and 14, respectively. As before, the salinity record was incomplete due to an apparent malfunctioning of the conductivity sensor, and only those data falling within a reasonable range (29-33 ppt.) are included. A complete record of the ebb tide was obtained. The data reveal general uniformity over depth but significant differences between east and west locations. This pattern was consistent with the patterns observed for the currents and temperature data.

In summary, results of physical measurements during the second pre-operational phase of the New Bedford Harbor Pilot Project suggest that the variables of interest were fairly constant over depth. However, significant differences were observed between east and west sampling locations. It is not known whether these differences are time or spatially dependent, since available instrumentation would not allow synoptic measurements.

Literature cited

Perkin, R.G. and E.L Lewis, 1980. The practical salinity scale 1978: Fitting the data. IEEE Jour. Oceanic Engineering 5:9-16.

Figure 1. Profile of the channel bottom under the Coggeshall St. bridge and approximate sampling locations.

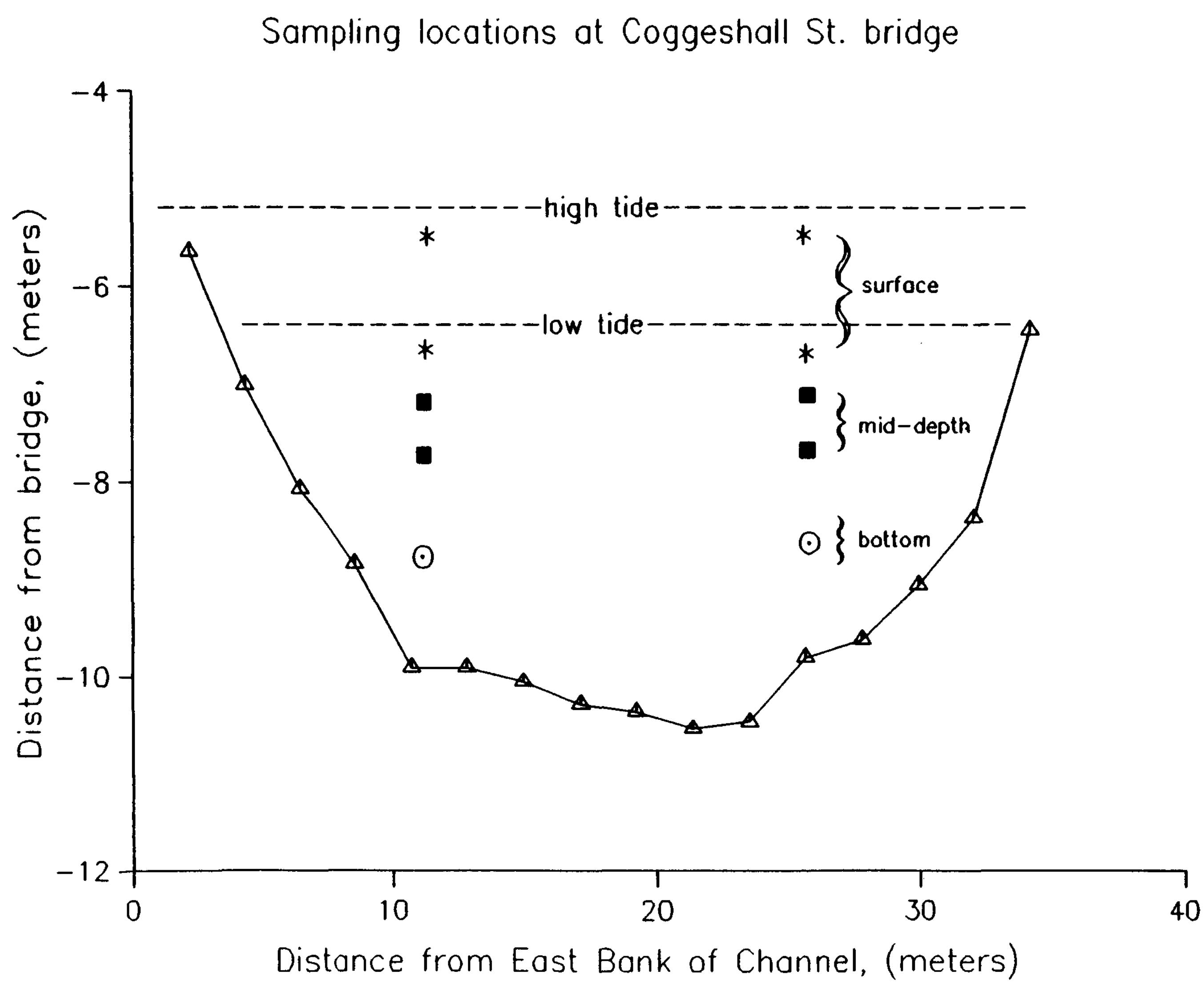
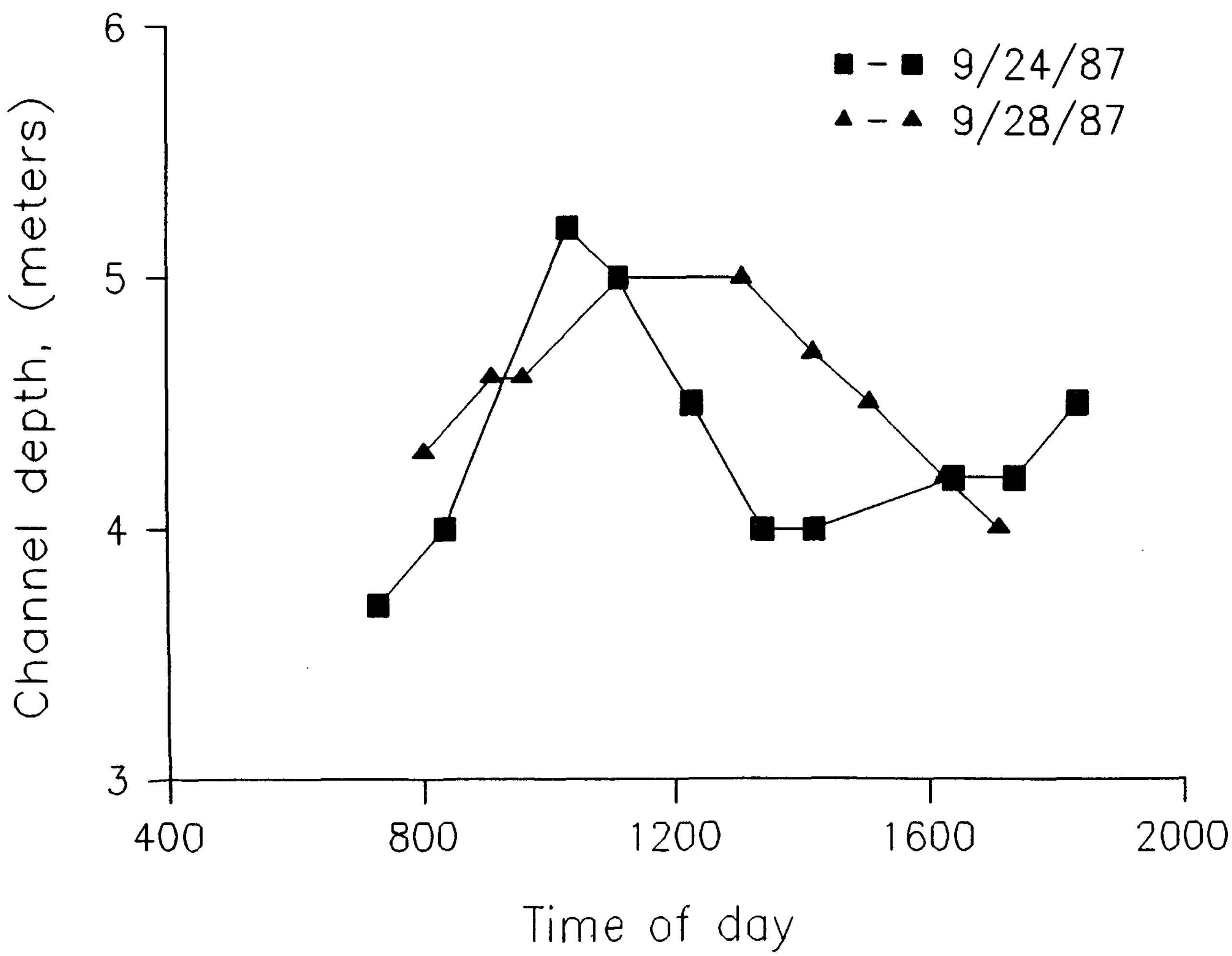


Figure 2. Water depth in the Coggeshall St. bridge channel vs. time during the second pre-operational phase sampling program.



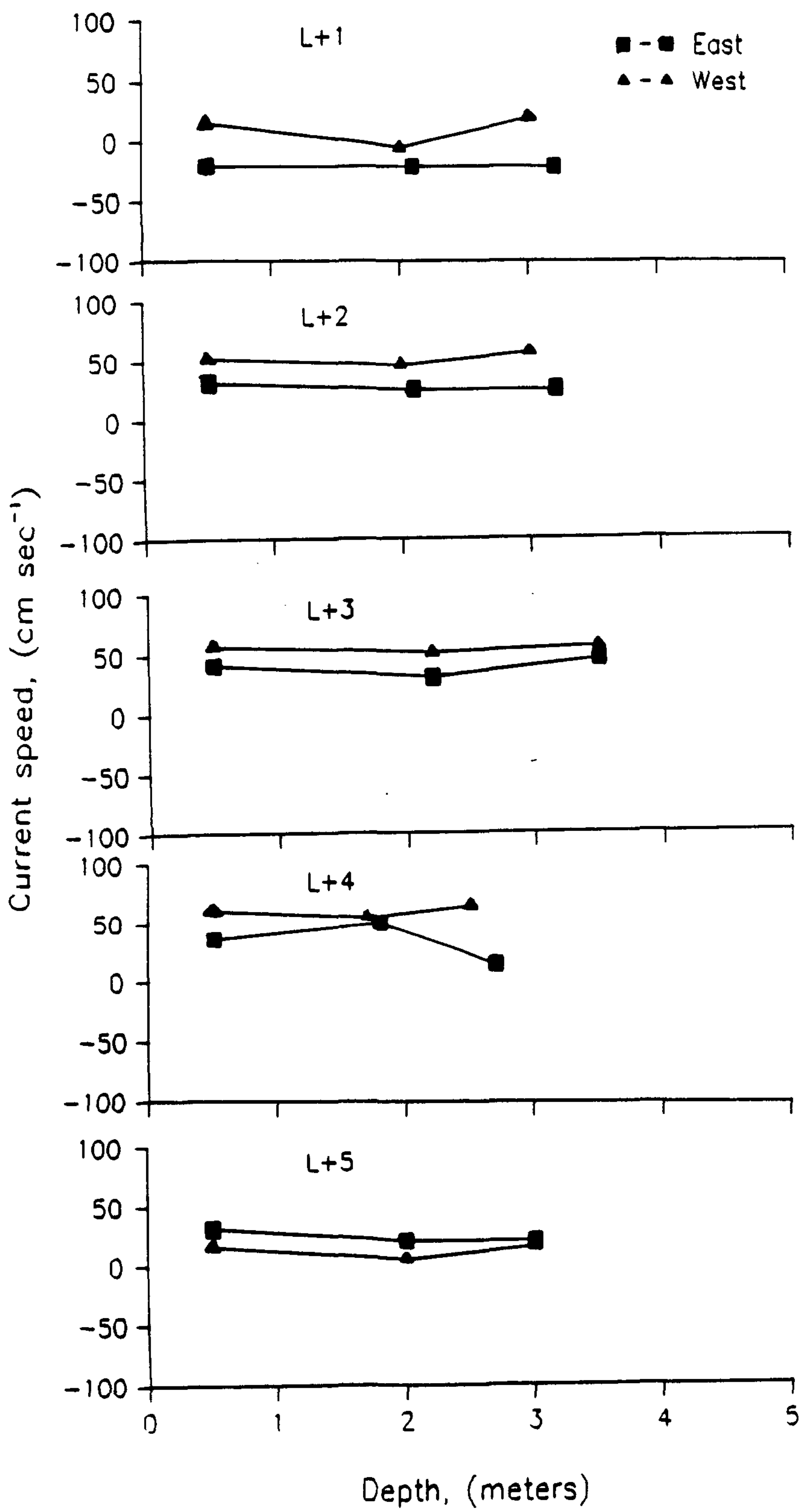


Figure 3. Profiles of current speed vs. depth for each of the 5 sampling periods on the flood tide of 9/24/87.

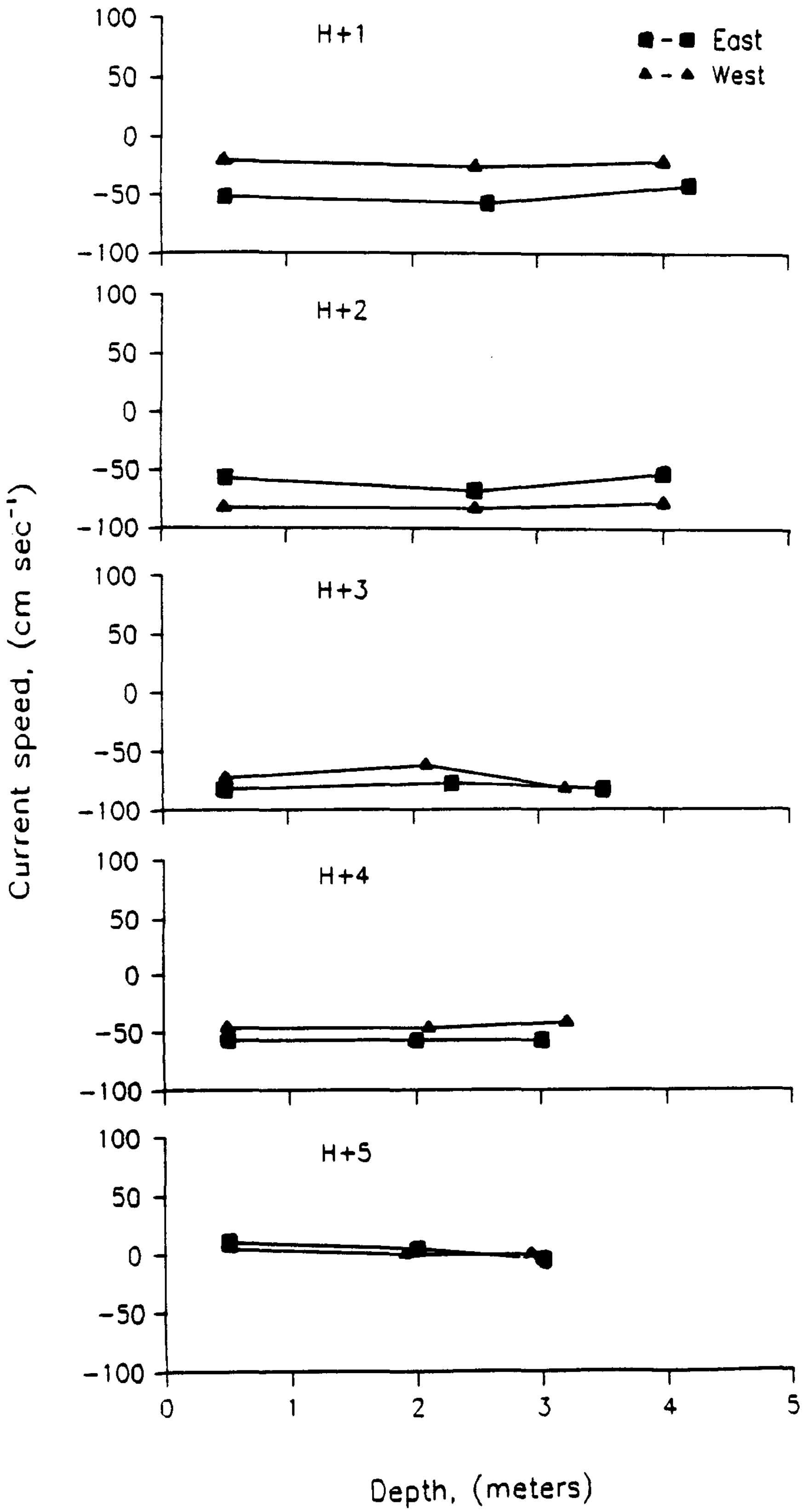


Figure 4. Profiles of current speed vs. depth for each of the 5 sampling periods on the ebb tide of 9/24/87.

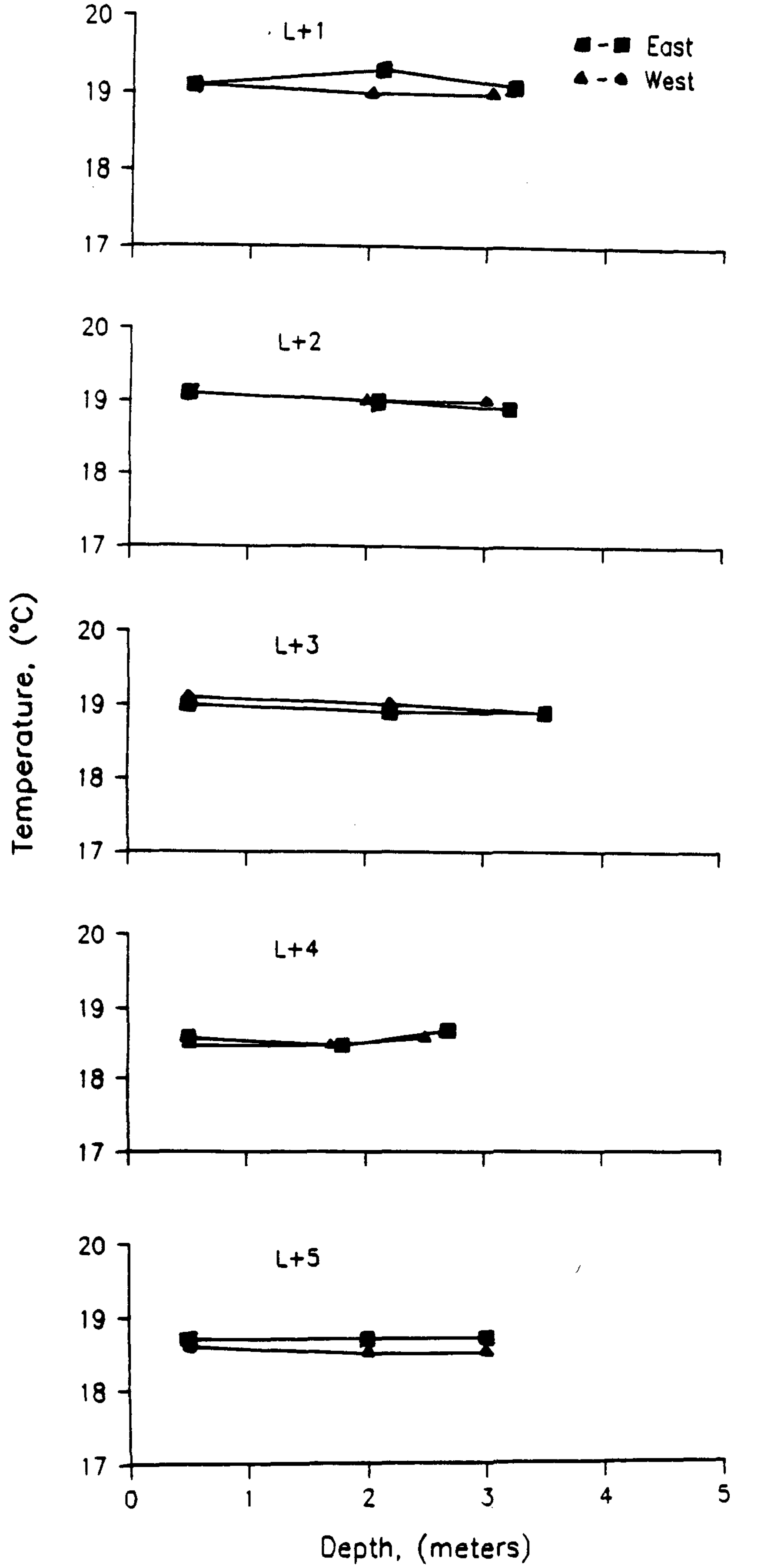


Figure 5. Profiles of temperature vs. depth for each of the 5 sampling periods on the flood tide of 9/24/87.

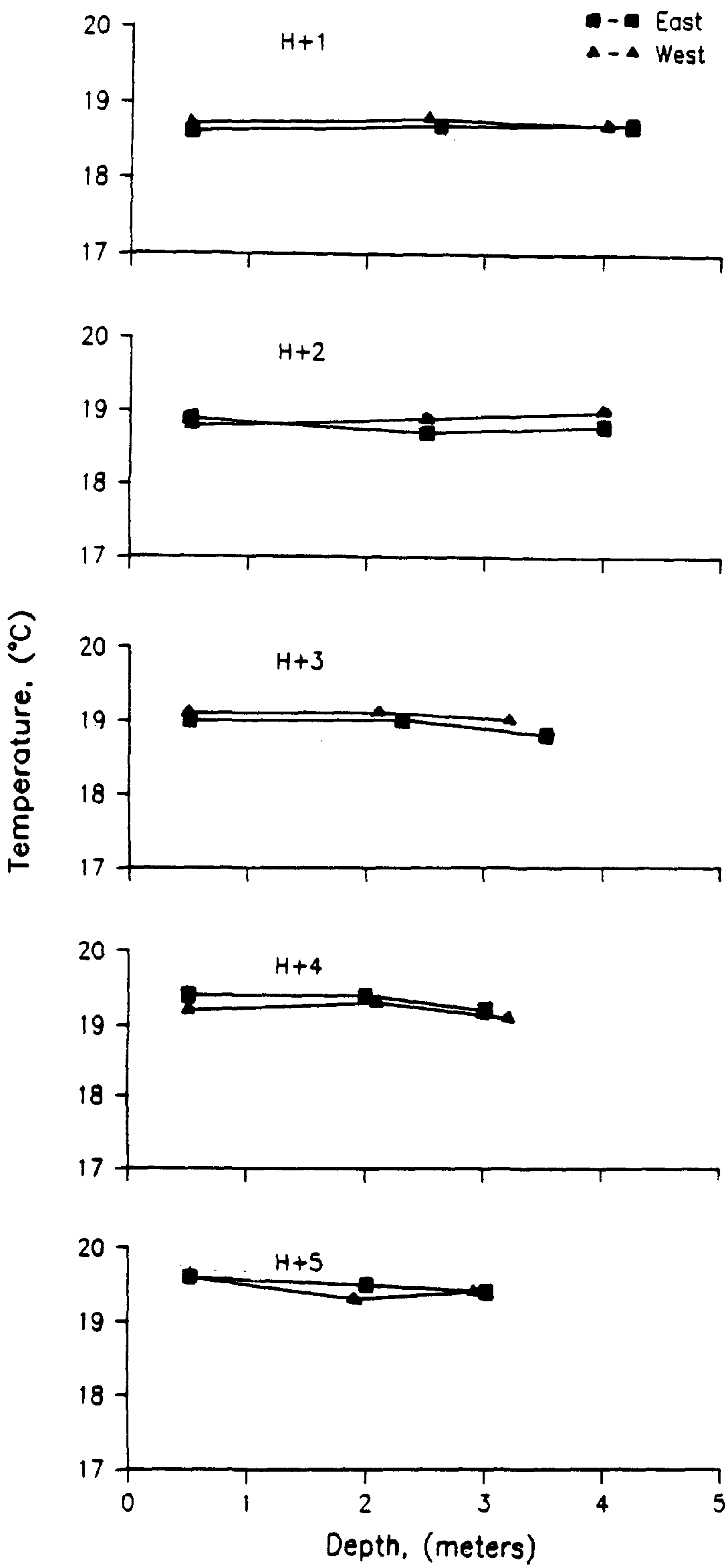


Figure 6. Profiles of temperature vs. depth for each of the 5 sampling periods on the ebb tide of 9/24/87.

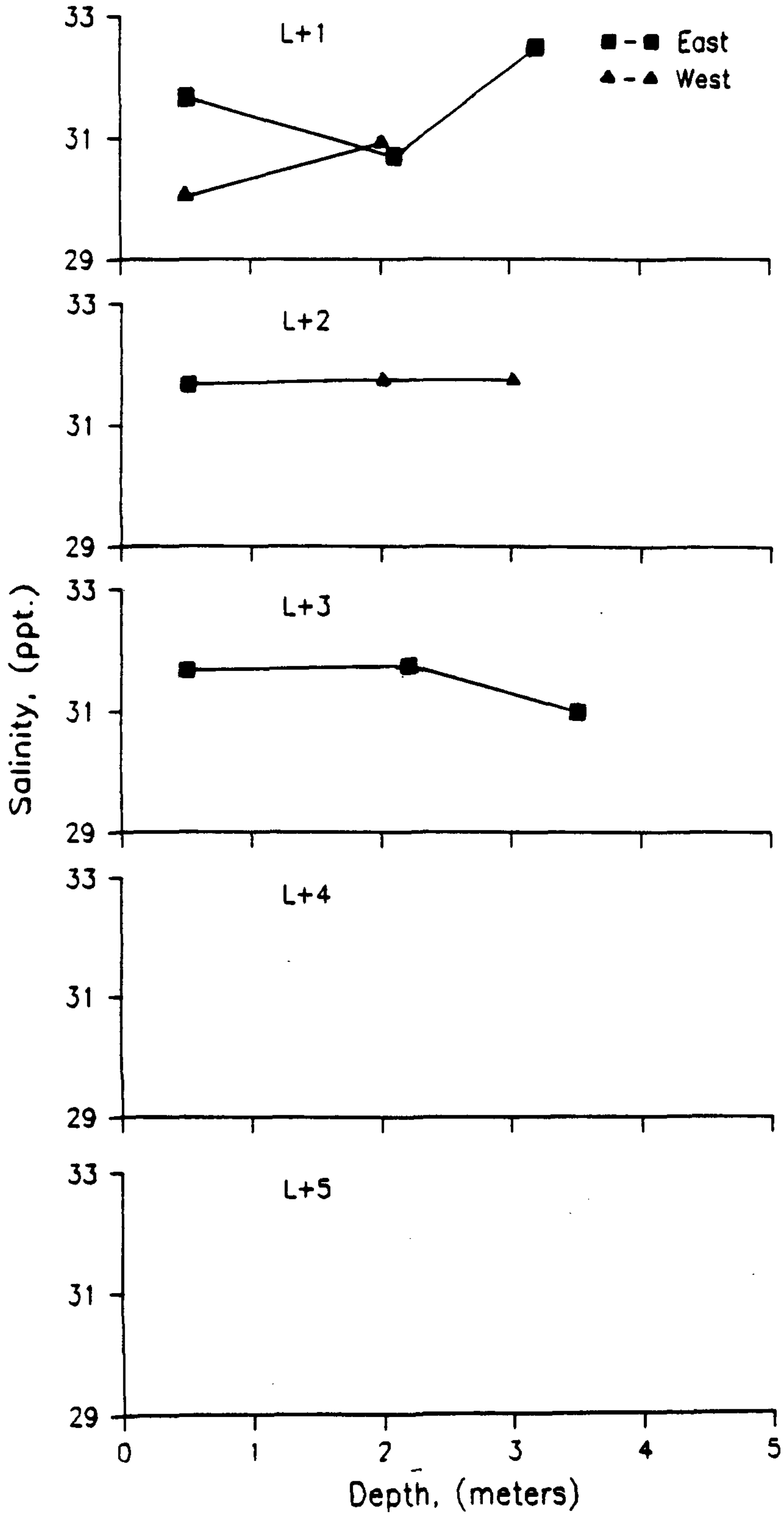


Figure 7. Profiles of salinity vs. depth for each of the 5 sampling periods on the flood tide of 9/24/87.

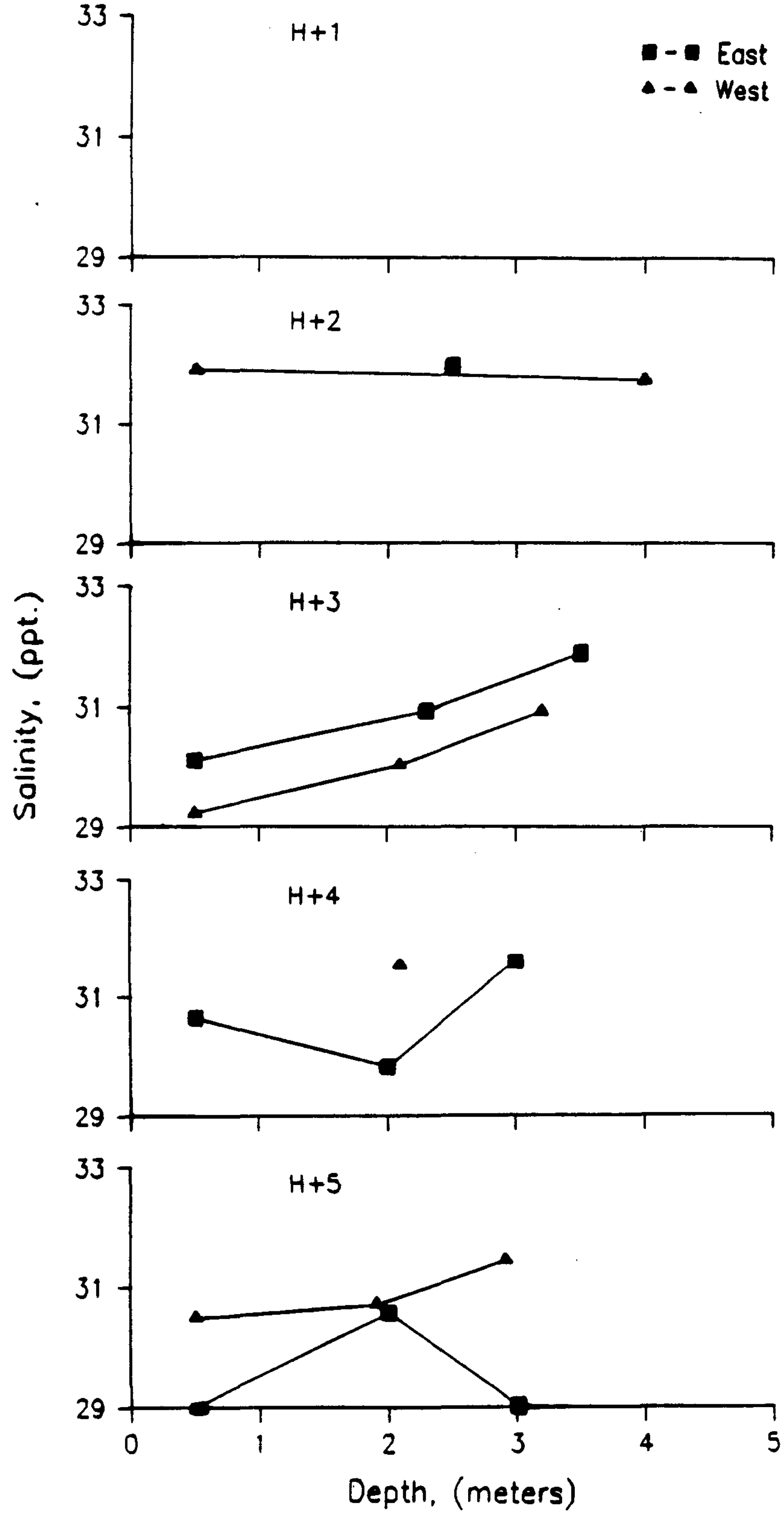


Figure 8. Profiles of salinity vs. depth for each of the 5 sampling periods on the ebb tide of 9/24/87.

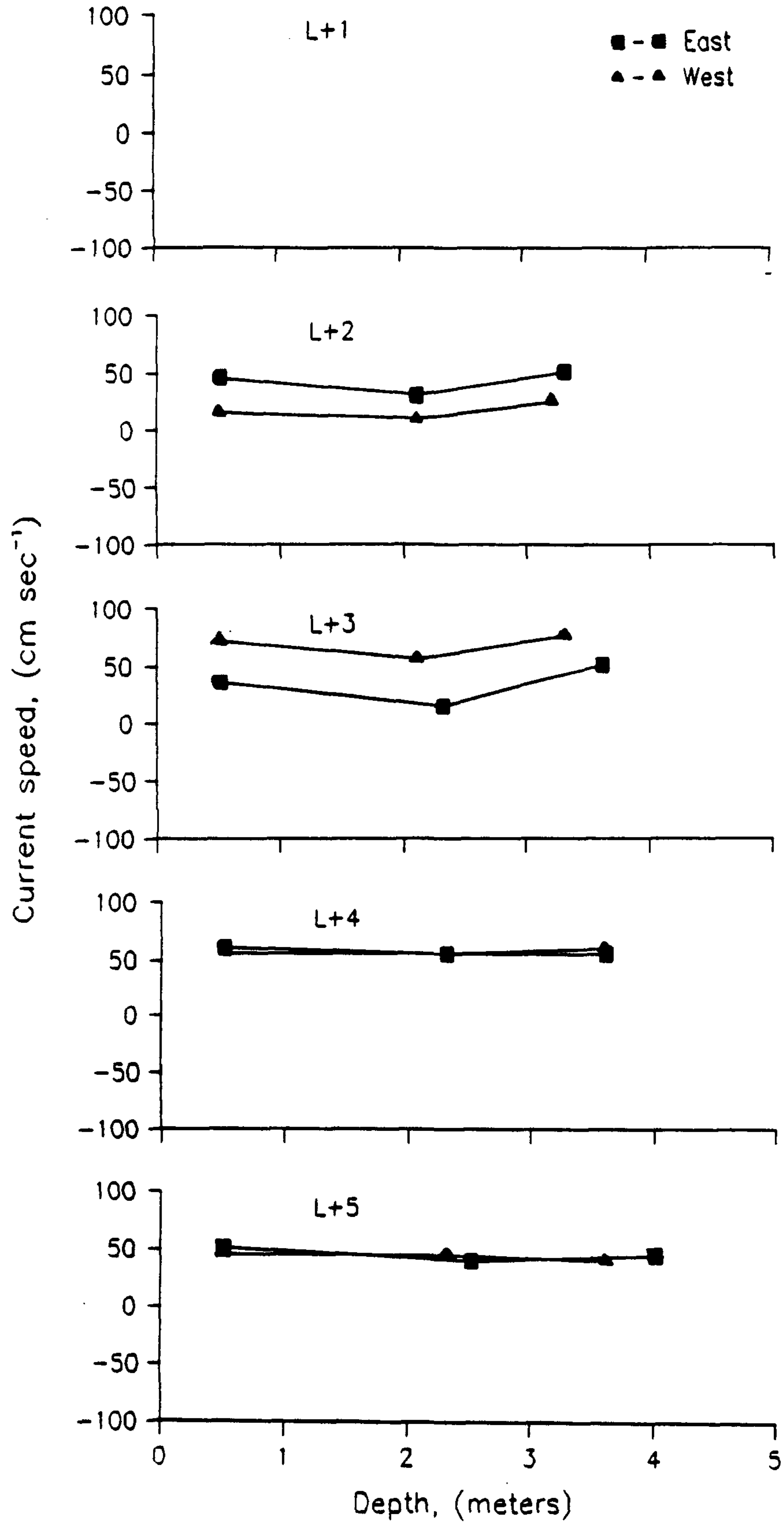


Figure 9. Profiles of current speed vs. depth for each of the 5 sampling periods on the flood tide of 9/28/87.

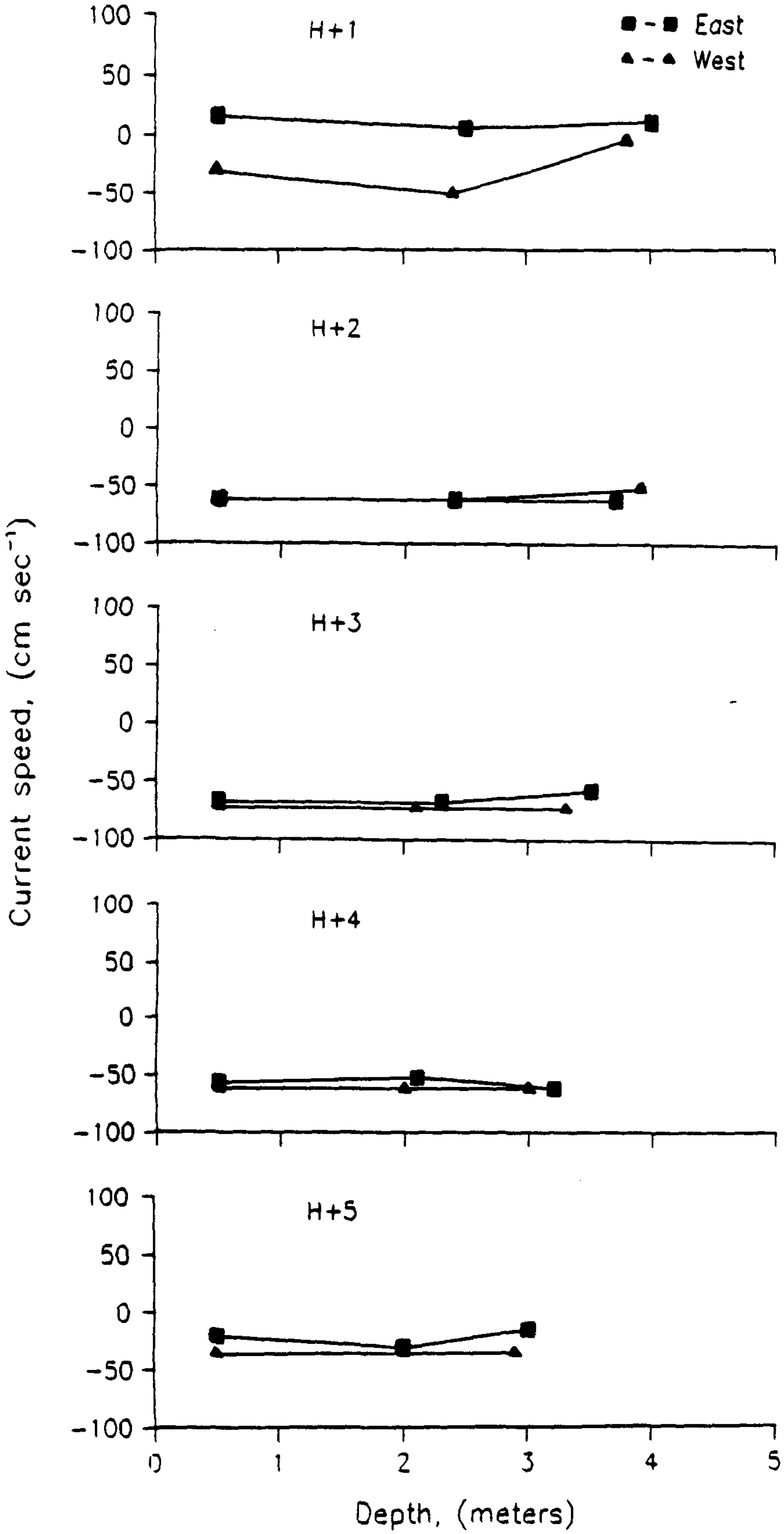


Figure 10. Profiles of current speed vs. depth for each of the 5 sampling periods on the ebb tide of 9/28/87.

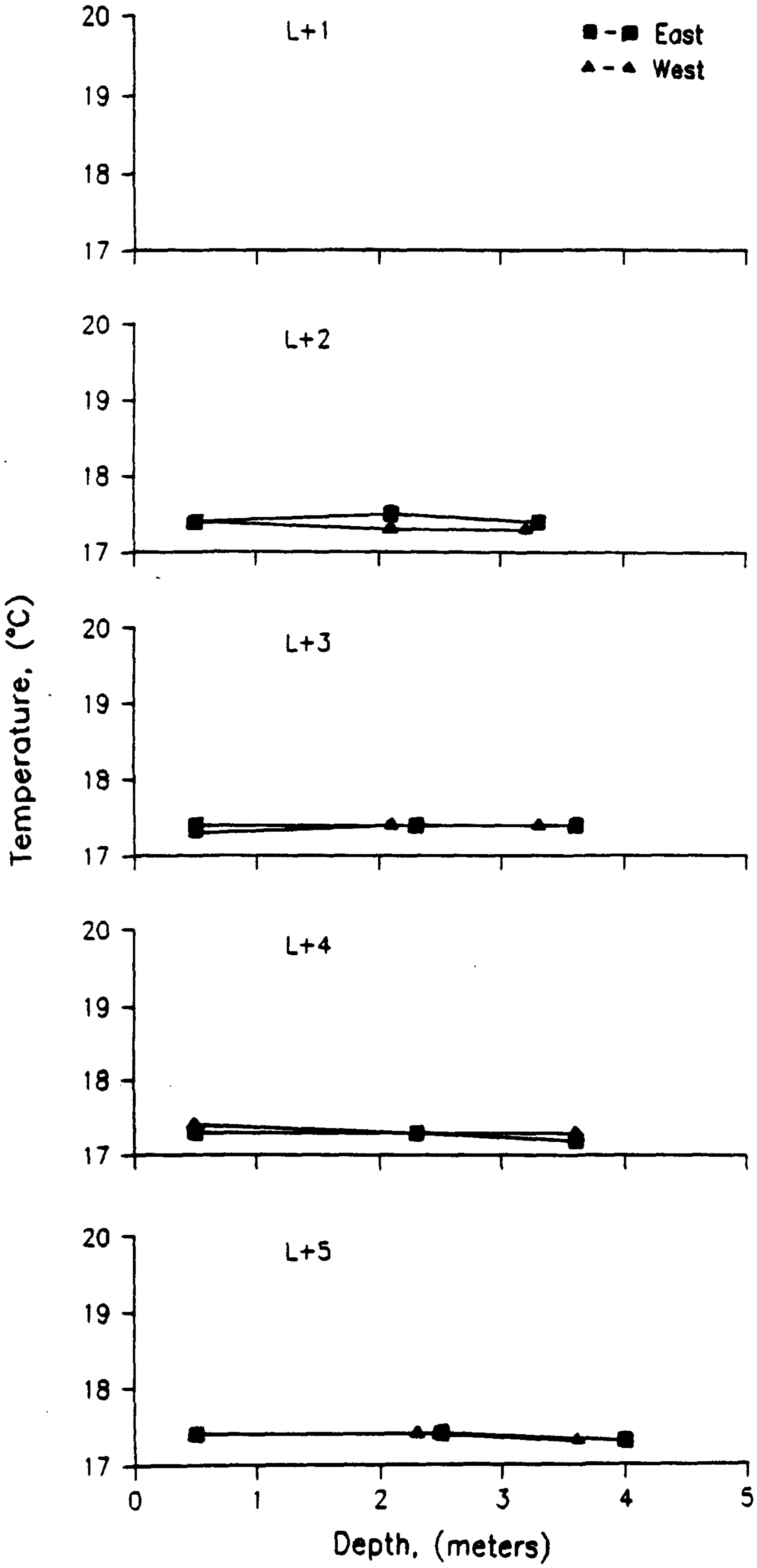


Figure 11. Profiles of temperature vs. depth for each of the 5 sampling periods on the flood tide of 9/28/87.

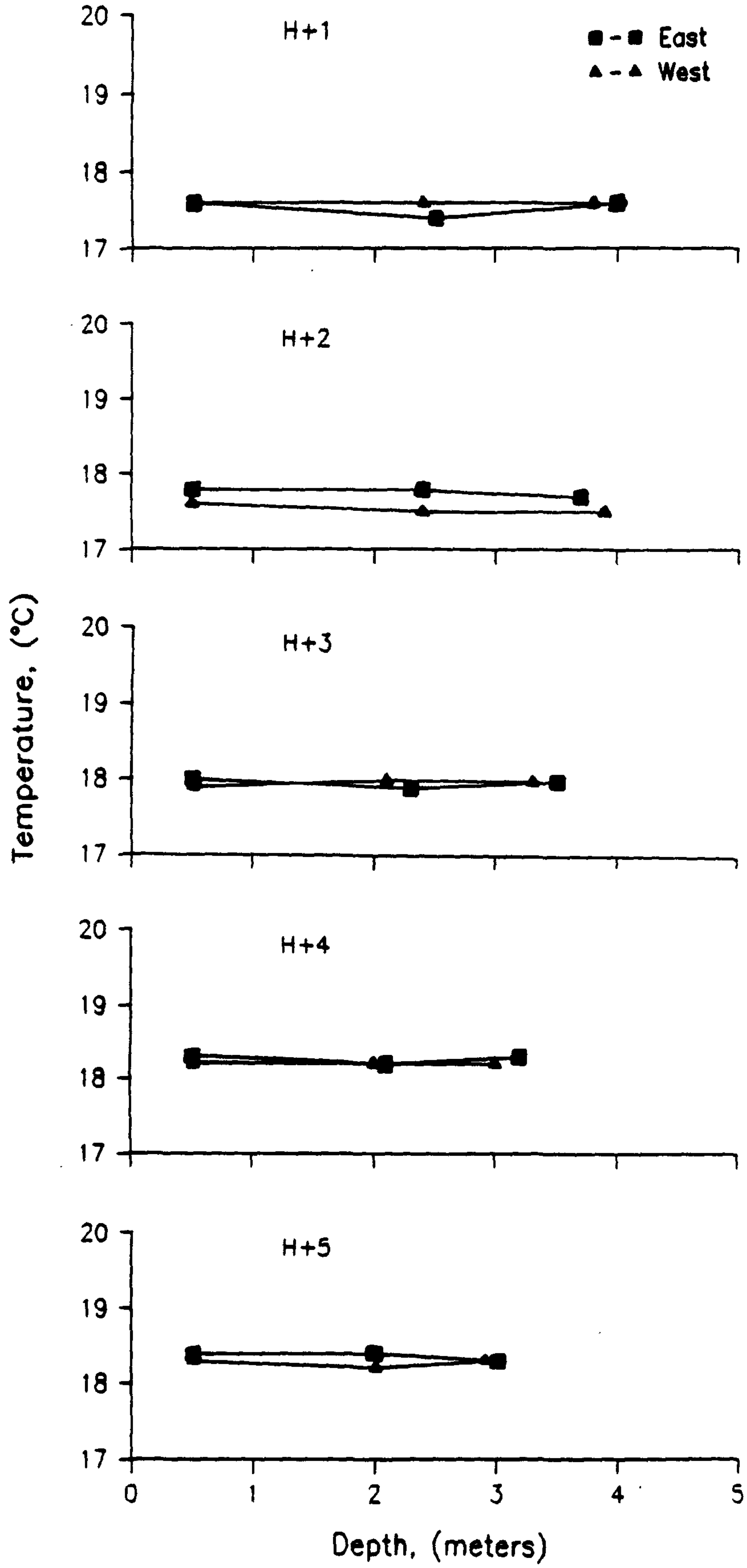


Figure 12. Profiles of temperature vs. depth for each of the 5 sampling periods on the ebb tide of 9/28/87.

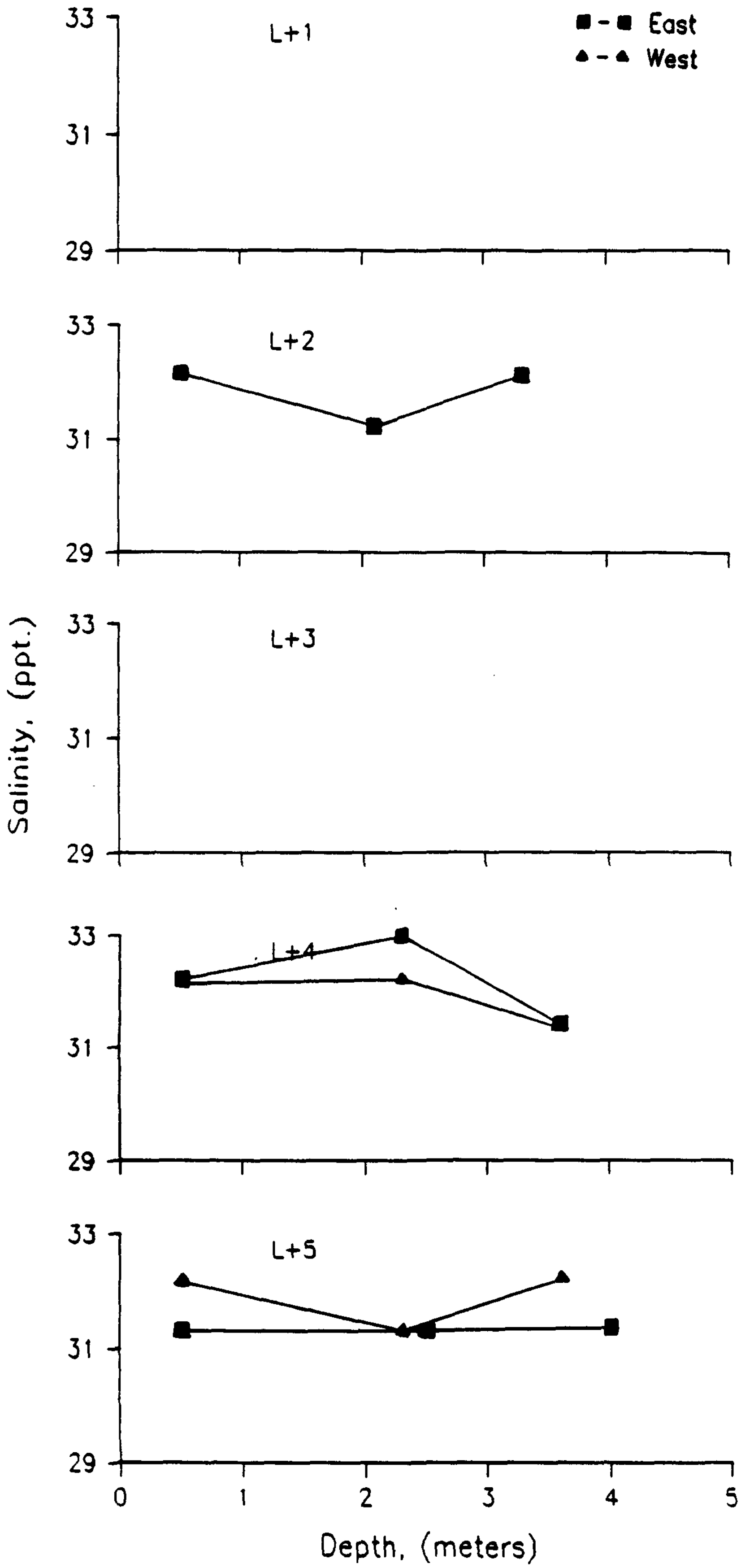


Figure 13. Profiles of salinity vs. depth for each of the 5 sampling periods on the flood tide of 9/28/87.

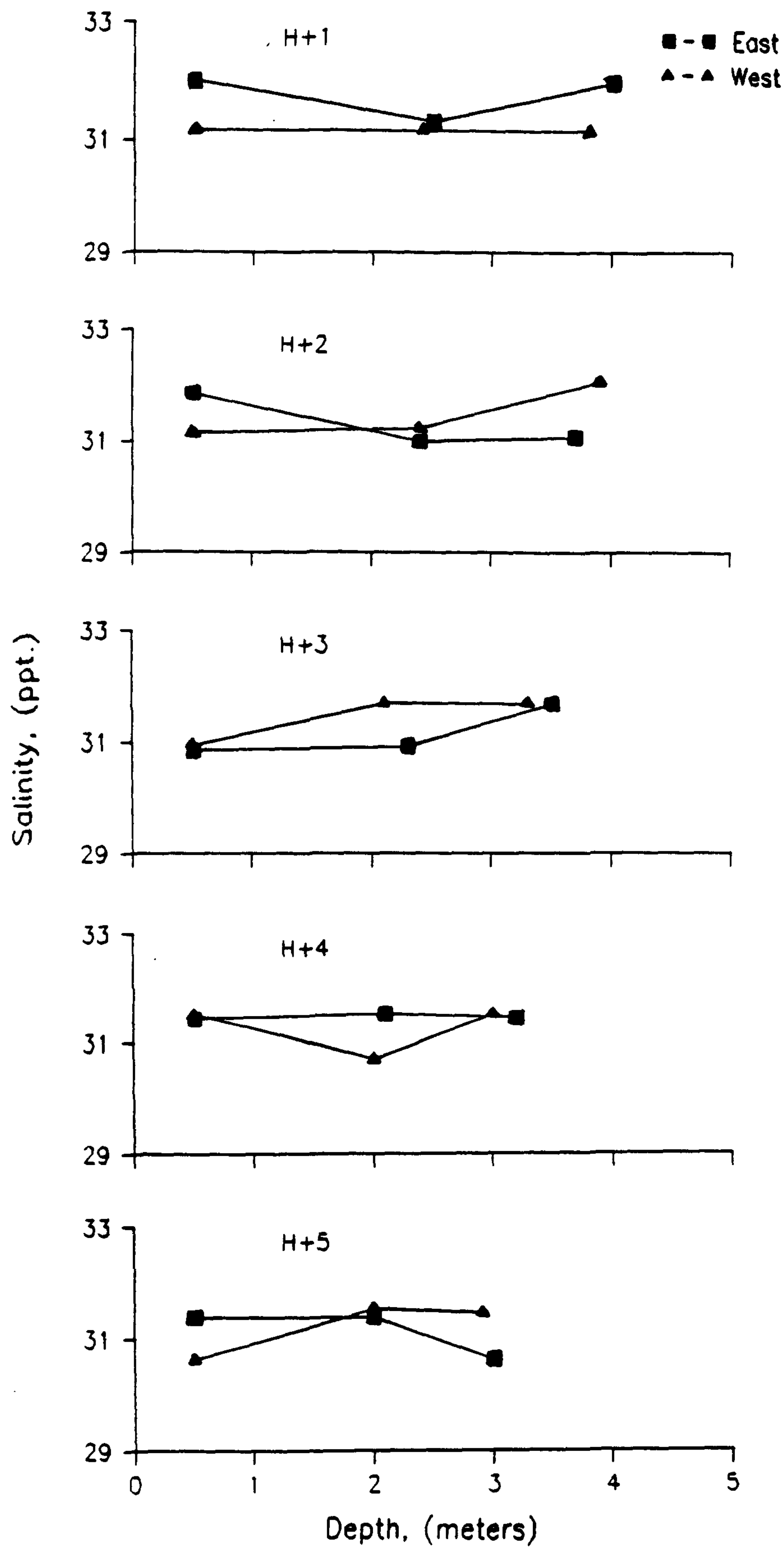


Figure 14. Profiles of salinity vs. depth for each of the 5 sampling periods on the ebb tide of 9/28/87.